Beyond SmartGrids: Making the electric grid secure, stable, reliable and resilient

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The electric sector is changing its paradigm, making necessary to adapt the industrial sector to such new model. This change is led by the irruption of the renewable energies, Energy storage, the integration of technologies of information and communication (TIC) and internet, which has provoked the evolution of the classic distribution grid to the Smart Grid, and now beyond that to the DigitalGrid.
Digital grid is the digitization of electricity networks using advanced technology. It allows two-way communication between the utility and the network, including its customers, and enables insight, automation and control across the utilities' operations, empowering utilities to improve reliability, availability and efficiency of the grid. The Digital Grid is the concept aiming to connect decentralized power from renewables, microgrids and virtual power plants, as well as energy storage, alongside traditional bulk generation; harness the potential of connected homes and devices and the internet of things as well as improve the reliability of current grids by making them smarter, able to self-detect and self-heal outages, and to reroute power as needed.
The Digital Grid concept is a key part of the future electrical grid and increases system complexity since interrelates the electrical system with the communication network. The evolution of the future electrical grid on the distribution network especially on urban areas may include enhanced communication capabilities and the penetration of renewable energies and energy storage leads to the application of mini and micro-grids (e.g. small communities, large buildings or manufacturing facilities). These grids are intended to be more or less self-sufficient in terms of power generation and may be key elements for increased resilience by applying self-healing and clusterization techniques.
In addition, the application of Internet of Thing based-elements (as devices and protocols) allows the acquisition of increased data and data sharing among components. Such development is also helping on the development of the Internet of Energy.
In this paper, different key developments on this are presented including risk assements [3], fault identification and location techniques [2] as well as self-healing and clusterization [1]; which copes with all the relevant steps of protection (planning, detection and mitigation) for the electrical systems.

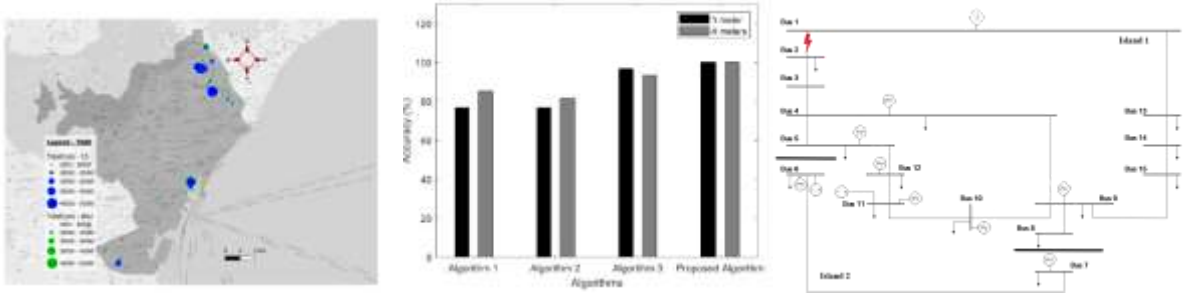

Figure 1: Risk Assement map against flooding (left); accuracy improvement for fault-location techniques (center), microgrid creation to minimize impact on users (right)

REFERENCES

[1] A. Ivanova, P. Paradell, J.L. Domínguez-García, A. Colet "Intentional Islanding of Electricity Grids using Binary Genetic Algorithm" 2nd Global Power, energy and Communication Conference (GPECOM), 2020, pp. 297-301
[2] P. Stefanidou-Voziki, C. Corchero, J.L. Domínguez-García " A Practical Algorithm for Fault Classification in Distribution Grids" 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe)
[3] D. Sanchez, J.L. Domínguez-García et al. " Electricl Grid Risk Assessment Against Flooding in Barcelona and Bristol Cities" Sustainablility (MDPI), vol 12(4), pp. 1527, 2020